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INK-JET INK

[*Inkujettoyoh inku*]

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[*There are no amendments to this patent.*]

Specification

1. Title of the invention

Ink-jet ink

2. Claims of the invention

An ink-jet ink consisting of a colorant and an organic solvent, which ink is characterized by the fact that fine particles of an inorganic material are included.

3. Detailed description of the invention

The present invention pertains to an ink used for ink-jet printing, and the invention further

pertains to an ink that can be effectively used as an ink-jet ink, in particular, an ink for ink-jet printer generator wherein adjustment of the ink ejection is made possible.

In recent years, use of an ink-jet generator where the ink is fed to a nozzle with a small diameter and ejected from the tip of the nozzle as particles as a means of recording in a recording device has been proposed. For example, use of the above-mentioned ink-jet generator for the recording head in printers and facsimile machines has been proposed. In the above-mentioned devices, the relative speed of the recording head and recording material is constant; thus, when the amount of ink ejected is maintained constant, lines with a constant width can be produced. However, in a device such as an XY plotter used for automatic drawing, the recording head moves in a two-dimensional direction and the relative speed between the recording head and the recording material changes; thus, when the amount of ink ejected is constant, a change in the line width occurs, and quality is sharply reduced. In order to eliminate the above problem, namely, in order to maintain constant the amount of the ink laid down per unit length of a line on the recording material, it is necessary to eject an amount of ink that corresponds to the relative recording speed. The means that can be used for changing the amount of ink ejected according to the relative recording speed varies depending on the means used for generating the ink particles. In an electric field ejection type ink-jet, the amount of the ink ejected can be changed when the bias voltage applied between the nozzle (or ink) and a counter electrode is made to correspond to the recording speed. However, when the inks of prior art are used, deflection occurs in the direction of ejection with an increase in the applied voltage, and the quality of the image is reduced.

[p. 2]

As a result of a study made on this topic, it was discovered that the quality of the image and the jet are significantly influenced by the properties of ink, in particular, the viscosity. In other words, when the ink of prior art is used, the ink flow velocity inside the nozzle is low when the voltage applied is low

and the viscosity is high, thus, when the viscous resistance is low, an adequate amount of ink is supplied to the nozzle tip, and in this case, a symmetrical electric field is generated between the nozzle and the ring electrode in the direction of the nozzle axis, and ejection of a jet in a direction along the nozzle axis is possible when the surface tension balance is good, but when the voltage applied is increased, the flow velocity inside the nozzle increases and the viscous resistance increases, and the amount of ink supplied to the nozzle tip is not sufficient; furthermore, the voltage on the counter electrode is increased further, and as a result, balance between the electric field and the surface tension is lost, and when a slight imbalance in the electric field occurs, the direction of the jet is deflected, or the jet is split; on the other hand, when the viscosity is low, the jet is hardly affected by the voltage applied and remains very stable, but diffusion on the recording material occurs; thus, the quality of the line is not adequate.

Therefore, for the ink used for an ink-jet with a variable ejection rate, it is necessary for (1) the range of change in the amount of ink ejected to be high to meet a wide range of recording speeds, in other words, for the viscosity to be low, and (2) for there to be an absence of diffusion on the recording material so that production of lines with high-quality can be achieved, in other words, rapid drying and high viscosity.

The purpose of the present invention is to produce an ink for ink-jet recording having the above-mentioned opposing properties, and in summary the invention is the production of an ink characterized by the fact that fine particles of an inorganic material are included in an ink-jet ink that consists of a colorant and an organic solvent.

For the fine particles of an inorganic material, metal oxides, carbonates, sulfates, and clays can be mentioned, and one or a mixture of two or more different types of the above-mentioned inorganic materials in combination can be used. In specific terms, SiO_2, Al_2O_3, FeO, Fe2O3, CaO, Mgo, Na_2O, K_2O, composite oxides thereof, and bentonite, montmorillonite, zeolite, etc. can be mentioned.

The particle diameter of the above-mentioned fine particles is 1 μm or less, and 0.1 μ or below is even more desirable, and in general, the ratio of the above-mentioned particles to the entire ink is in the range of 1 wt% to 30 wt%, preferably 1 wt% to 5 wt%, though it depends on the particle diameter.

When the above-mentioned inorganic materials are used, a cationic activating agent, etc. can be used in order to disperse the material in the ink, and when needed, the material can be used as a clay composite of bentonite, for example, and a higher aliphatic amine or a higher aliphatic quaternary ammonium salt.

In this case, standard solvents commonly used such as xylene, toluene, and benzene, can be used, and as in the case of the colorant, is not especially limited. Furthermore, the mixing ratio is not especially limited, and ratios commonly used can be used in this case as well.

When fine particles are included in the ink of concern in the present invention, the apparent viscosity of the ink that flows inside the nozzle is high at the time of low-speed [printing], and low at the time of high-speed [printing], and forms a pseudo-viscous liquid; thus, the ink becomes stable over a wide range of applied voltage as in the case of an ink with a low viscosity; thus, the range of change in the amount of ink ejected can be increased, and the ink particles collide with the recording material and stop. In other words, the velocity is reduced, and the ink behaves as an ink with high viscosity, and as a result, a high-quality line can be produced.

In the following, the present invention is explained in detail with application examples.

[Application Example 1]

Xylene 91 parts by weight

Oil Black HBB 7 parts by weight

Organic bentonite (particle diameter: 0.5 μ or below) (Composite of bentonite and a long-chain quaternary ammonium salt) 2 parts by weight

Thorough mixing and dispersing were carried out for the above-mentioned composition so as to produce an ink-jet ink.

[Application Example 2]

Xylene 91.5 parts by weight

Oil Black HBB 7 parts by weight

Amorphous silica (mean particle diameter: 12 mμ) 1.5 parts by weight

The composition above was used to produce an ink-jet ink.

[Application Example 3]

Xylene 98.5 parts by weight

Carbon black (mean particle diameter 20 to 30 mμ) 1.5 parts by weight

An ink-jet ink was prepared with the above-mentioned composition. In this case, the carbon black functions both as a colorant (black) and as the fine particles of an inorganic material.

[Comparative Example]

Xylene 68 parts by weight

Oil Black HBB 7 parts by weight

Silicon varnish 25 parts by weight

Thorough mixing and dispersion were carried out for the above composition to produce an ink-jet ink. In this case, the silicon varnish acts as a thickener and pseudo-viscous characteristics cannot be achieved in this case.

Each ink produced above was placed in a BL-type viscometer and the viscosity was measured. Furthermore, each ink was loaded in an ink-jet generator and the relationship between the voltage applied and the amount of ink ejected was studied. The results obtained above are shown in Fig. 1 and

Fig. 2.

As shown in the results in Fig. 1, the viscosity remains constant in the ink of the prior art even when the shear stress corresponding to the flow velocity of the ink inside the nozzle increases, but the viscosity is reduced in the ink of concern in the present invention with an increase in the shear rate and pseudo-viscous characteristics are observed. Furthermore, as shown in Fig. 2 and Fig. 3, the injection state of the ink of concern in the present invention remains good even when the voltage applied is increased (for reference, see Fig. 3A and 3B), the rate of ejection increases exponentially as the voltage applied increases; thus, the amount of ink ejected can be changed over a wide range according to a wide range of change in the voltage applied, on the other hand, the ejection state is undisturbed when the voltage applied is increased in the ink of the prior art (see Fig. 3C for reference), and an adequate change in ink ejection cannot be achieved.

In Fig. 2, the dotted line portion of the curve that shows the characteristics of the ink of the Comparative Example shows a deflection in the ink-jet jetting direction.

Furthermore, when a recording test was performed for the ink of the present invention with an XY plotter, a high-quality line with a constant line width was produced.

4. Brief description of figures

Fig. 1 shows the relationship between the voltage applied and the amount of ink ejected and Fig. 2 shows the relationship between the shear rate and the viscosity, and Fig. 3A, 3B, 3C and 3D show the ink ejection state at the tip of the nozzle at points corresponding to A, B, C and D in Fig. 2.

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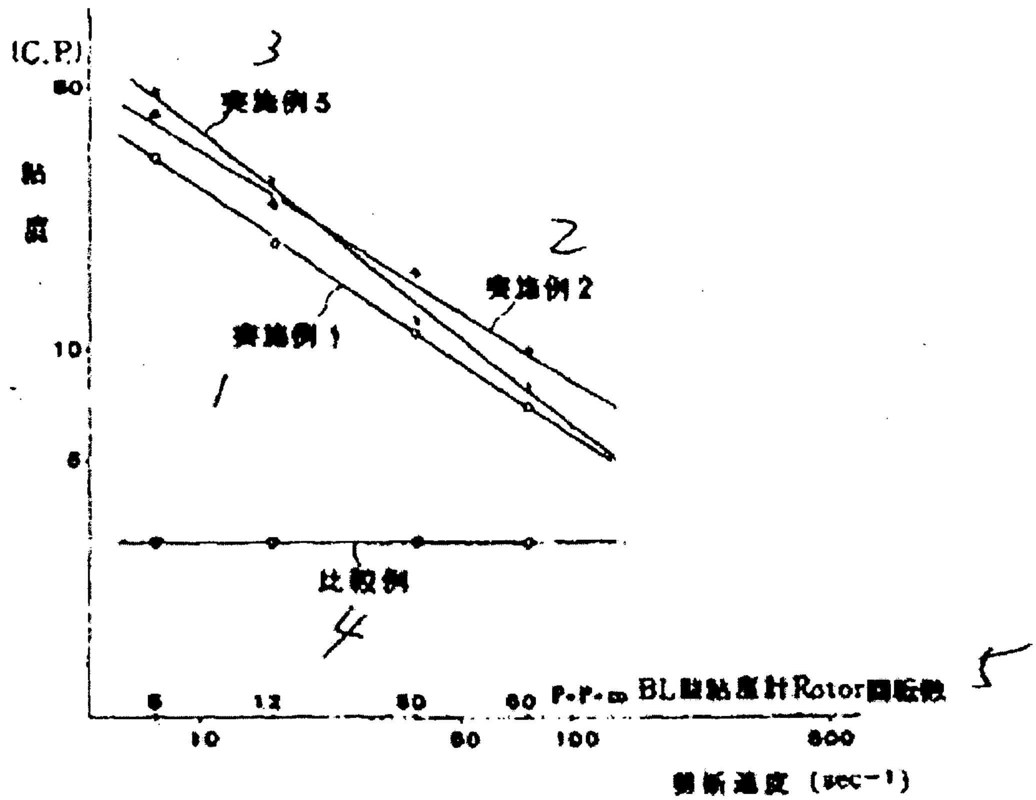
Fig. 1



Vertical axis: Viscosity (C.P.)

Horizontal axis: Shearing speed (sec-1)

Key:

1 Application Example 1

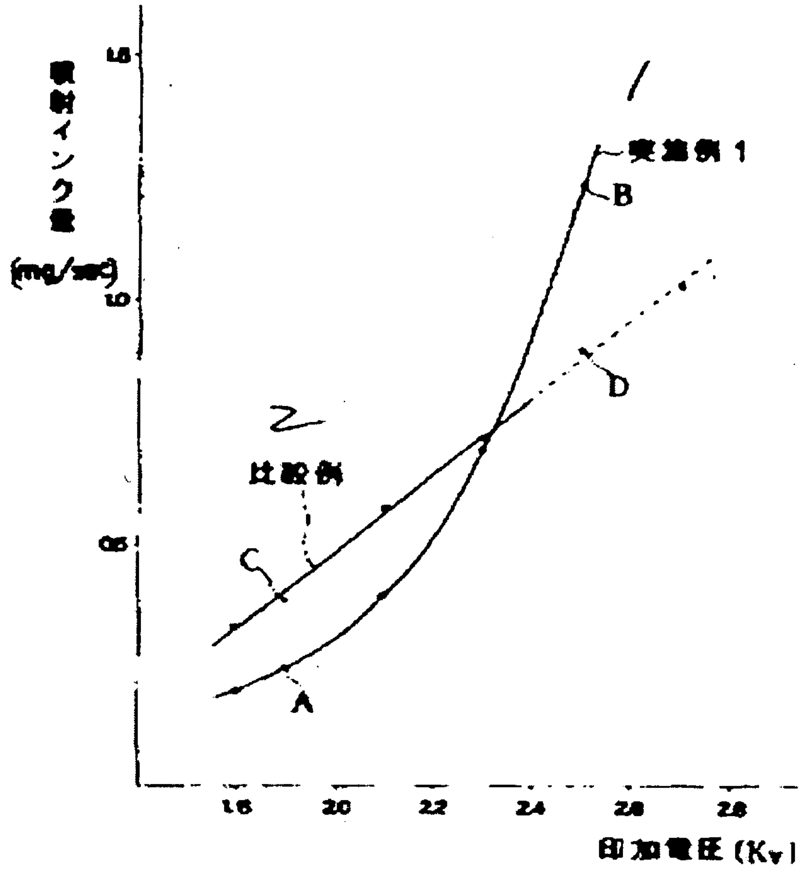
2 Application Example 2

3 Application Example 3

4 Comparative Example

5 P[dot]P[dot][m or infinity] BL type viscometer Rotor rotation p.p.m

Fig. 2



Vertical axis: Amount of ink ejected (mg/sec)

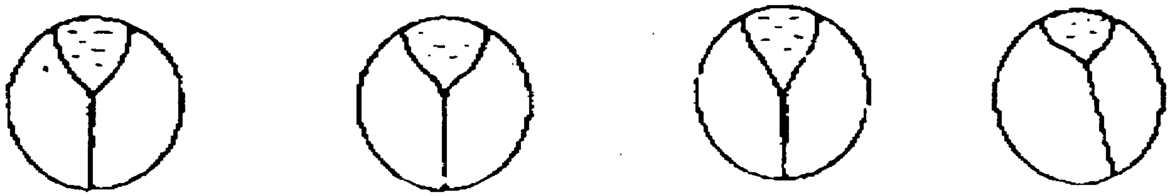
Horizontal axis: Voltage applied (Kv)

Key:

1 Application Example 1

2 Comparative Example

Fig. 3



A B C D